# Space Weather Technical Forecast

Issued on Wednesday, 24 April 2024 at 01:24 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

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**Space Weather Forecast Headline: Further M-class flares expected (R1/R2 blackouts). Chance of isolated G1/Minor Storm intervals from peripheral CME effects.**

**Solar Activity:** Moderate with four M-class flares observed, the largest observed reaching M3.6 at 23/0319UTC from AR3654 in the southeast. Sixteen sunspot regions, fifteen numbered, currently feature on the visible side of the solar disc. This includes a broad complex in the southwest; including AR3638/45/47/43, with the spots magnetically connected and complex in places. Several other regions are also moderately sized, in general these remain more stable with simpler bipolar configurations, however AR3654 in the southeast and AR3646 in the northern disk have seen further development and likely represent an increasing flare risk.

Multiple CMEs observed in available imagery over the previous 24hr, although limited clear Earth directed potential. The most likely candidates a recent CME associated with a M1.6 flare from AR3638 at 22/2116UTC, associated with a 395km/s type II radio emission, perhaps bringing a glancing risk into day 4 (27 Apr). We await model output and further analysis of the CME associated with the M3.0 flare from the AR3638 region at 23/1710UTC and likely associated type II radio burst.

**Solar Wind / Geomagnetic Activity:** Solar winds observed by ACE at L1 were slightly elevated to background throughout, on a steady trend, currently near 370km/s. Below average density throughout. The Interplanetary Magnetic Field (IMF) Bt, was weak 4-6nT, with the north-south component, Bz, varying weakly between -6/+6nT. Phi angle was predominately negative (towards the Sun). Geomagnetic activity was Quiet to Unsettled (Kp1-3).

**Energetic Particles / Solar Radiation:** High energy proton flux (greater than 10MeV) observed at GOES18 was at Background. High energy electron flux (greater than 2MeV) observed at GOES16 was generally Moderate throughout. The associated 24-hour fluence remained below Active (1e8 integrated flux), but with a rising trend, reaching 3.13e7 integrated pfu at 24/0000 UTC.

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Occasional M-class flares are expected to continue, with a slight chance of isolated X-class flares. The greatest risk from the large complex of sunspots in the southwest.

**Solar Wind / Geomagnetic Activity:** There are several CMEs that are anticipated to pass close to the Earth through the period, with potential of glancing interactions. This gives low confidence to the detail for the geomagnetic forecast. Solar winds have eased to slow-ambient levels, and in the absence of CME influence should continue at similar levels to start the period. A further enhancement likely by day 3 (26 Apr) however, in association with CH27/+ currently near centre disc, likely seeing winds increasing back towards slightly elevated or elevated levels though into day 4 (27 Apr).

Overall, geomagnetic activity expected to remain mainly Quiet initially, with Unsettled intervals.

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However, any CME arrivals will give a chance of Active intervals and a chance of G1 Minor Storms, this risk peaking into day 2 (25 Apr). Activity perhaps more generally increasing by later day 3 (26 Apr) with Unsettled to Active conditions expected by the end of the period given positive HSS influence.

**Energetic Particles / Solar Radiation:** High energy proton flux is expected to remain at background levels, but with a chance of rising in response to any large flares that occur, predominately from the complex of sunspots in the southwest. This bringing a slight chance of reaching the S1 Minor Radiation Storm threshold throughout.

High energy electron flux as observed by GOES16 is expected to display a slowly rising trend, increasingly Moderate and likely peaking at High diurnal values early in the period, however this may be limited by any glancing CME impacts that occur. The associated 24-hour electron fluence is expected to remain generally below the Active (1e8 integrated pfu) threshold but with a rising trend, giving an increasing chance of reaching the Active threshold into day 2 (25 Apr) but reducing thereafter.

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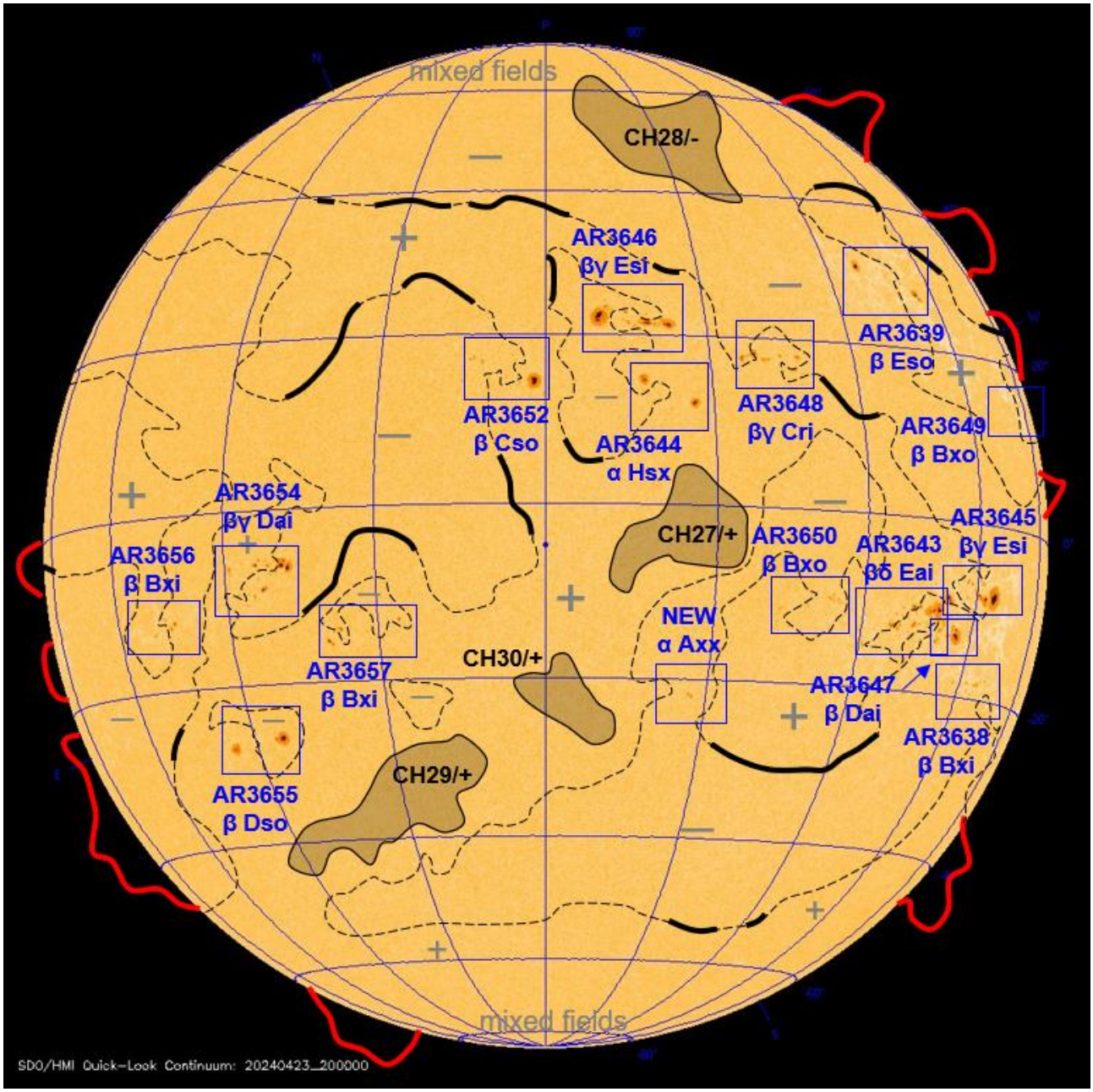
**Figure 1. Solar Analysis Valid 23/2000UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

Multiple CMEs associated with the complex sunspot region in the southwest have been observed in recent days, including a recent CME associated with a M3.0 flare at 23/1710UTC from AR3638 and type II radio burst for which we await model output. Analysis suggests CMEs may pass close to Earth through the period, largely glancing to the south. These CMEs may be too weak for much of a noticeable impact, but there is the potential for an increase in geomagnetic activity from any glances that occur, particularly through day 2 (25 Apr). Otherwise solar winds have eased to slow-ambient wind conditions in the absence of CME and HSS enhancement. A further enhancement likely by day 3 (26 Apr) however, in association with CH27/+ currently near centre disc, likely seeing winds increasing back towards slightly elevated or elevated levels though into day 4 (27 Apr).

Overall, geomagnetic activity expected to remain mainly Quiet initially, with Unsettled intervals. However, any CME arrivals will give a chance of Active intervals and a chance of G1 Minor Storms, this risk peaking into day 2 (25 Apr). Activity perhaps more generally increasing by later day 3 (26 Apr) with Unsettled to Active conditions expected by the end of the period given positive HSS influence.

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 15 | 25 | 20 | 15 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

Multiple CMEs associated with the complex sunspot region in the southwest have been observed in recent days. Analysis suggests CMEs may pass close to Earth through the period, largely glancing to the south.

**Figure 2: MOSWOC ENLIL Ensemble output**

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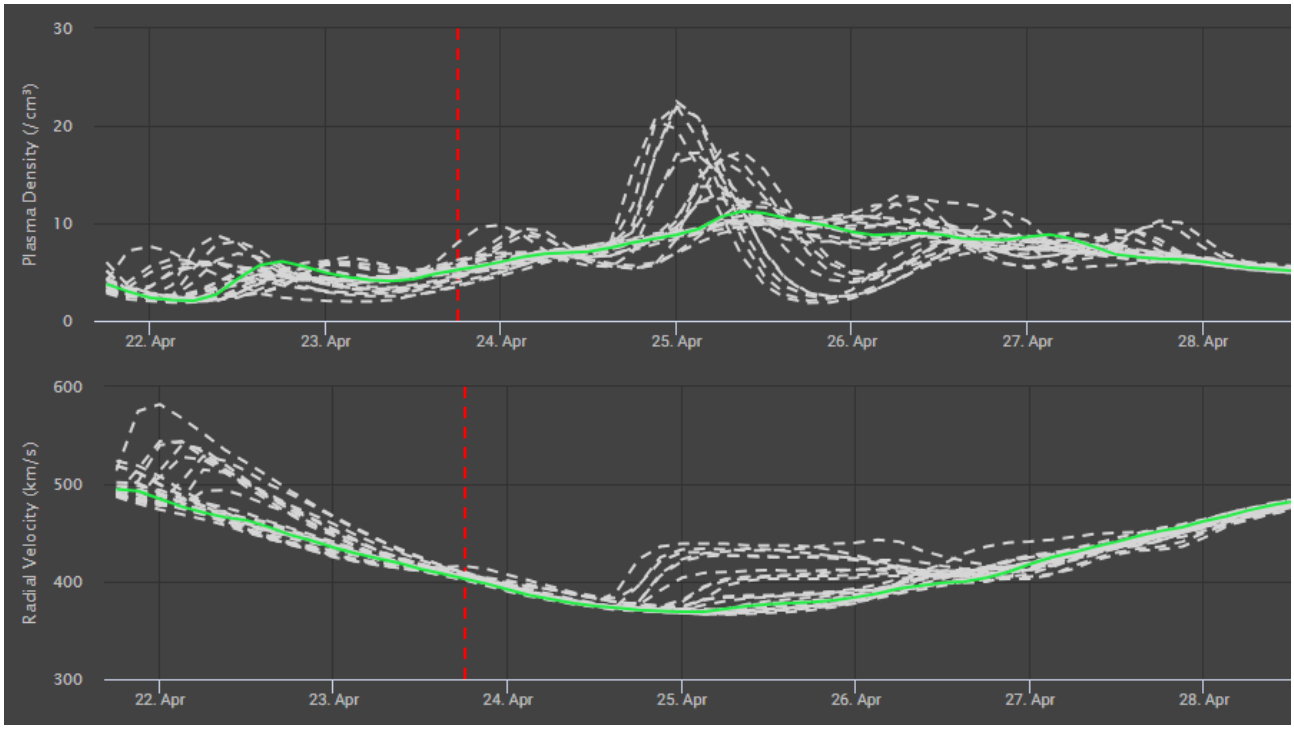


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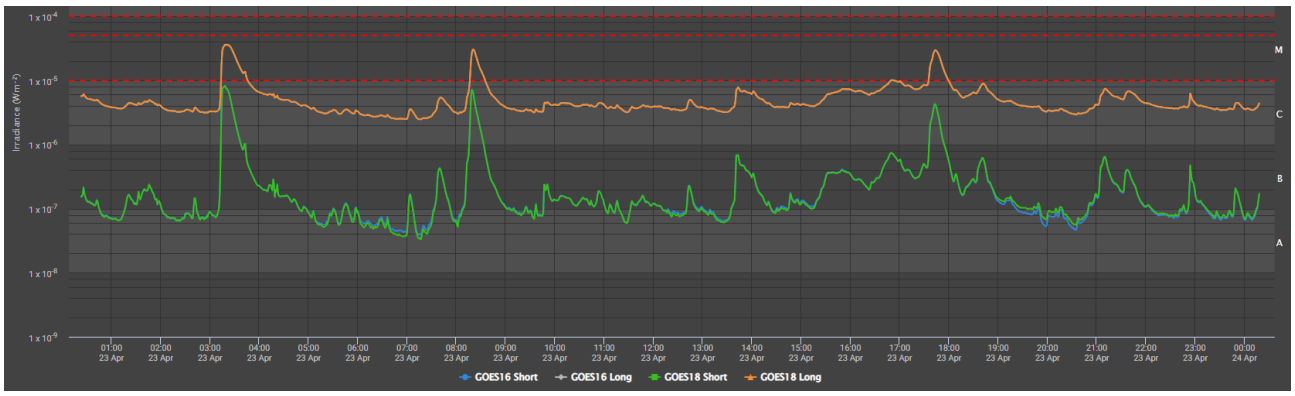
**Radio Blackouts - X-Ray Flares:**
Moderate activity is expected to continue through this guidance period, with occasional M-class flares expected and a slight chance of isolated X-class flares.

With sixteen sunspot regions, fifteen numbered, currently on the visible solar disc conditions remain highly complex with multiple flare producing regions and high background flux. The broad complex in the southwest; including AR3638/45/47/43 continues to carry a large percentage of the current flare risk, with the spots magnetically connected and complex in places. The visually small and simple AR3638 in the leading portion of this group continuing to be the source of frequent flaring. Several other regions are also moderately sized, in general these remain more stable with simpler bipolar configurations, however AR3654 in the southeast and AR3646 in the northern disk have seen further development in recent hours and represent an increasing portion of the flare risk.

The cluster of regions in the southwest will approach and begin to round the western limb through day 3 (26 Apr) but will likely continue to present a flare risk throughout the period depending on further developments. With no significant returning regions expected during the period, or currently signaled on far side sounding data to counterbalance the loss of flare potential a general reduction in flare risk likely, but not until perhaps the very end of the forecast period.

| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | Yes | 80 | 80 | 80 | 80 |
| Very Active | R3 to R5 X Class | No | 10 | 10 | 10 | 10 |

**Figure 3: Latest 24hr GOES18/16 X-ray trace**

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**Solar Radiation Storms - (High Energy Protons):**
High energy proton flux as observed by GOES18 has persisted at Background. There remains a slight chance of enhanced flare activity, primarily from the cluster of sunspot in the southwest disc, which could increase the proton flux at Earth. This bring a slight chance of reaching the S1 Minor Solar Radiation Storm level throughout the period.

| Radiation Storms<br>Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 15 | 15 | 15 | 15 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

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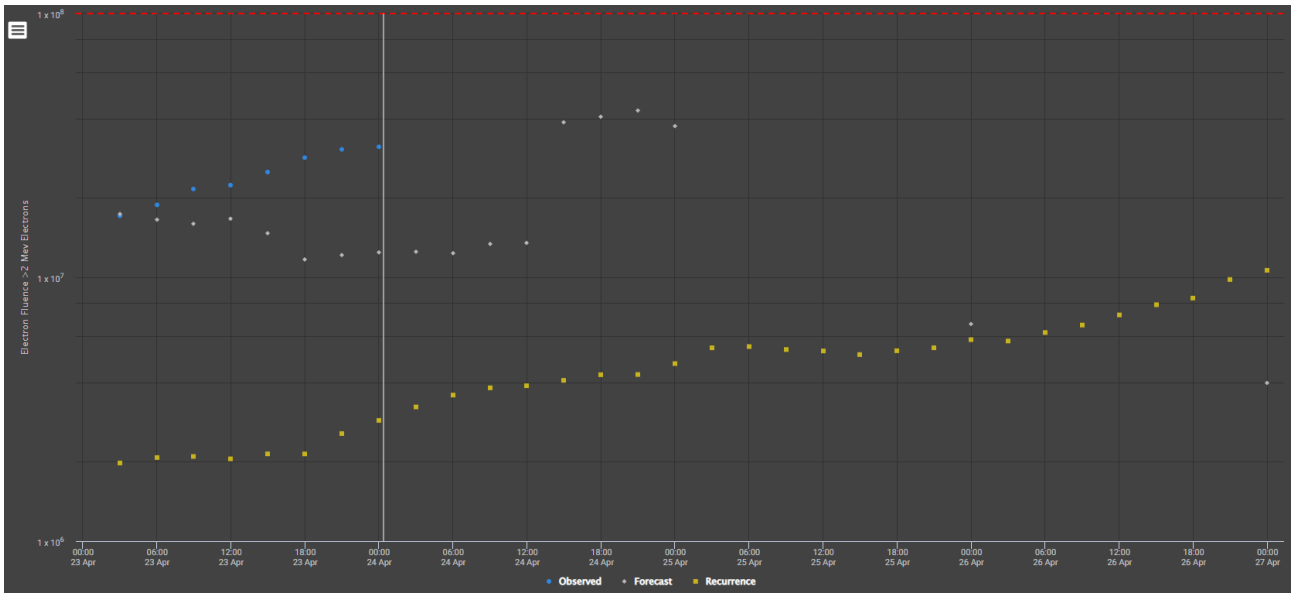
**High Energy Electrons Event (≥ 2MeV):**
High energy electron flux as observed by GOES16 rose to persistent Moderate levels during 22 Apr, likely as a result of the recent CME arrival and HSS onset that had been observed on previous days. As solar winds likely continue to slowly ease, any charging that has occurred at lower L-shells is expected to become increasingly relevant at GEO, with the observed flux increasingly likely peaking at High levels during diurnal maxima into days 1 and 2 (24-25 Apr). This is only moderate confidence however, as the arrival of any CMEs and associated geomagnetic activity may help to modulate the observed flux, and any more notable arrivals have the potential to drop values back towards Background. Expected HSS influence by days 3 and 4 (26-27 Apr) will also likely bring a similar reduction in flux values back towards Background to Moderate levels.

The associated 24 hour electron fluence is thus expected to continue on a generally upward trend in the near term, as indicated by Met Office REFM output, which looks to be providing reasonable guidance in the absence of any CME arrivals, but likely under-estimating peak values. This will give a increasing chance of reaching the Active threshold by day 2 (25 Apr), although this potential will reduce should any dropout from any CME arrival occur and remains only moderate confidence, and reduces by the end of the period given potential HSS influence.

| GEO Electron Environment<br>Probability (Exceedance) | Level ($cm^{-2}\ sr^{-1}\ day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ 2 MeV ≥ $1x10^8$** | No | 25 | 30 | 20 | 10 |
| **Very Active** | **≥ 2 MeV ≥ $1x10^9$** | No | 1 | 1 | 1 | 1 |

**Figure 4: Latest MOSWOC REFM output**

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